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ASSESSMENT OF QUARTERLY
COLLECTED GROUNDWATER SAMPLES
RCRA IMPOUNDMENT
CABOT CORPORATION PLANT
TUSCOLA, ILLINOIS

(U.S. EPA I.D. No. ILD042075333)

Date: September 1984

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ASSESSMENT OF QUARTERLY COLLECTED GROUNDWATER SAMPLES

INTRODUCTION

This report is the quarterly assessment of groundwater quality for the hazardous waste impoundment at the Cabot Corporation plant near Tuscola, Illinois. The report has been prepared to satisfy the requirements of Section 725. 193(d) (5), Subpart F: Groundwater Monitoring.

Groundwater quality assessment reports are to be prepared as indicated in "Groundwater Quality Assessment Program at Cabot Corporation Plant, Tuscola, Illinois", as amended. The assessment program had been prepared to satisfy the requirements of Section 725. 193(d) (2) and submitted to IEPA in February 1984. In the supplements to the assessment program, the hazardous waste constituents to be analyzed were identified, the number of wells in the monitoring system were modified, and a new schedule of sampling and analysis were established. These modifications were approved by the IEPA. Previous to this quarterly report, a semi-annual assessment report was submitted to the IEPA in July 1984.

The purpose of this report is to assess the rate and extent of migration and the concentration of hazardous waste constituents in the groundwater beneath the plant property in vertical and horizontal directions based on the quarterly sampling.

Monitoring System

As approved by the IEPA, nine wells out of thirteen make up the monitoring system for the impoundment at the Cabot plant (Figure 1). Of these, MW-1 (G101) is the background well and the rest are downgradient. MW-9 (G109) and MW-13 (G113) are the deep monitoring wells which are installed to assess vertical migration of hazardous waste constituents.

Hazardous Waste Constituents

Four hazardous waste constituents were identified in the groundwater samples from the monitoring wells in the plant property. These constituents are:

Bis (2-Ethyl hexyl) phthalate
Carbon tetrachloride
Tetrachloroethlylene
Methylene chloride

Parameters Analyzed and Assessment Methods

The quarterly samples were collected from the monitoring wells on July 10, 1984. These samples were analyzed for the four hazardous waste constituents. The results of the analyses were submitted to the IEPA in August, 1984. The results are also summarized in Table 1. In addition to the above four parameters, seven more parameters were identified in the samples as shown in

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Table 1. Concentration of hazardous waste constituents in the groundwater samples from the monitoring wells, Cabot Corporation plant, Tuscola, Illinois

	G101	G106	G107	G108	G109	G110	G111	G112	G113
Collection Date	7/10/84	7/10/84	7/10/84	7/10/84	7/10/84	7/10/84	7/10/84	7/10/84	7/10/84
Carbon tetra chloride UG/L	<1	8	3	1900	<1	<1	<1	<1	<1
Methylene chloride UG/L	<1	9	8	64	9	<1	<1	<1	<1
Tetrachloroethylene UG/l	<1	5000	20	764	152	<1	<1	<1	<1
Bis (2-Ethyl hexyl) phthalate UG/l	<10	<10	<10	<10	<10	<10	<10	<10	<10
Benzene	N.D.	<1	47	5	N.D.	N.D.	N.D.	N.D.	N.D.
Toluene	N.D.	17	<1	56	N.D.	N.D.	N.D.	N.D.	N.D.
*Ethylbenzene	N.D.	3	<1	9	N.D.	N.D.	N.D.	N.D.	N.D.
1,1,1 - Trichloroethane	N.D.	<1	<1	40	N.D.	N.D.	N.D.	N.D.	N.D.
1,1,2,2 - Tetrachloroethane	N.D.	<1	<1	15	N.D.	N.D.	N.D.	N.D.	N.D.
Chloroform	N.D.	<1	7	330	N.D.	N.D.	N.D.	N.D.	N.D.
Trichloroethylene	N.D.	<1	9	<1	N.D.	N.D.	N.D.	N.D.	N.D.

* It is not in the list of hazardous waste of IPCB (1984)

N.D. means not detected.

Table 1. The new parameters were not identified in the previous water samples which were analyzed at a different commercial laboratory. Presently, these new parameters are included as information. However, if they are identified in future samples, the hazardous waste constituents to be analyzed and assessed will be expanded.

ASSESSMENT

Hazardous Waste Constituents in Groundwater

Review of the analysis results in Table 1 indicates that three of the four hazardous waste constituents were measurable and have entered groundwater. The analyzed parameters were below their respective detection limits in the background well (G101) while measurable levels were found in the immediately downgradient wells (G106, G107, and G108) from the impoundment. This indicates that the hazardous waste constituents have primarily migrated from the impoundment. However, the concentrations were low, in ppb level, in the mentioned downgradient wells; except, tetrachloroethylene was 5.00 mg/l and carbon tetrachloride was 1.9 mg/l in wells G106 and G108, respectively. Tetrachloroethylene was 152 ppb and methylene chloride 9 ppb in G109.

The analyses results in Table 1 differ from those in the semi-annual report of July 1984. It appears that carbon tetrachloride is measurable in low concentrations in G106 and G107, while it was below the detection limit previously. Carbon tetrachloride increased from 0.18 mg/l to 1.9 mg/l in well G108. Methylene chloride decreased in well G106 from 250 ppb to 9 ppb, while it increased slightly in wells G107 and G108. Tetracholorethylene decreased from 430 ppb to 20 ppb and from 1540 ppb to 764 in wells G107 and G108, respectively; on the contrary, the concentration increased from 2400 ppb to 5000 ppb in well G106. Furthermore, both methylene chloride and tetrachloroethylene became slightly higher, 9 ppb and 152 ppb, in relatively deep well G109. As before, bis (2-ethyl hexyl) phthalate was below the detection limit in all wells. All four parameters in the background well (G101) were below their detection limits.

The above differences would result from seasonal differences, sample contamination, changes of waste concentration in the impoundment in the past, change in discharge rate from the impoundment or laboratory errors (personal or equipment).

Rate and Extent of Migration of Hazardous Waste Constituents

Review of the analysis results in Table 1 in conjunction with the location of shallow monitoring wells (Figure 1) shows that three of the hazardous waste constituents were above their detection limits in the monitoring wells (G106, G107 and G108) which are immediately downgradient from the impoundment. All four parameters were below their detection limits in recently drilled three shallow monitoring wells (G110, G111 and G112).

Although these analysis do not indicate the extent of contamination (or the location of the contamination front), they show that the groundwater contamination occured primarily near the impoundment in the downgradient direction. The groundwater along the

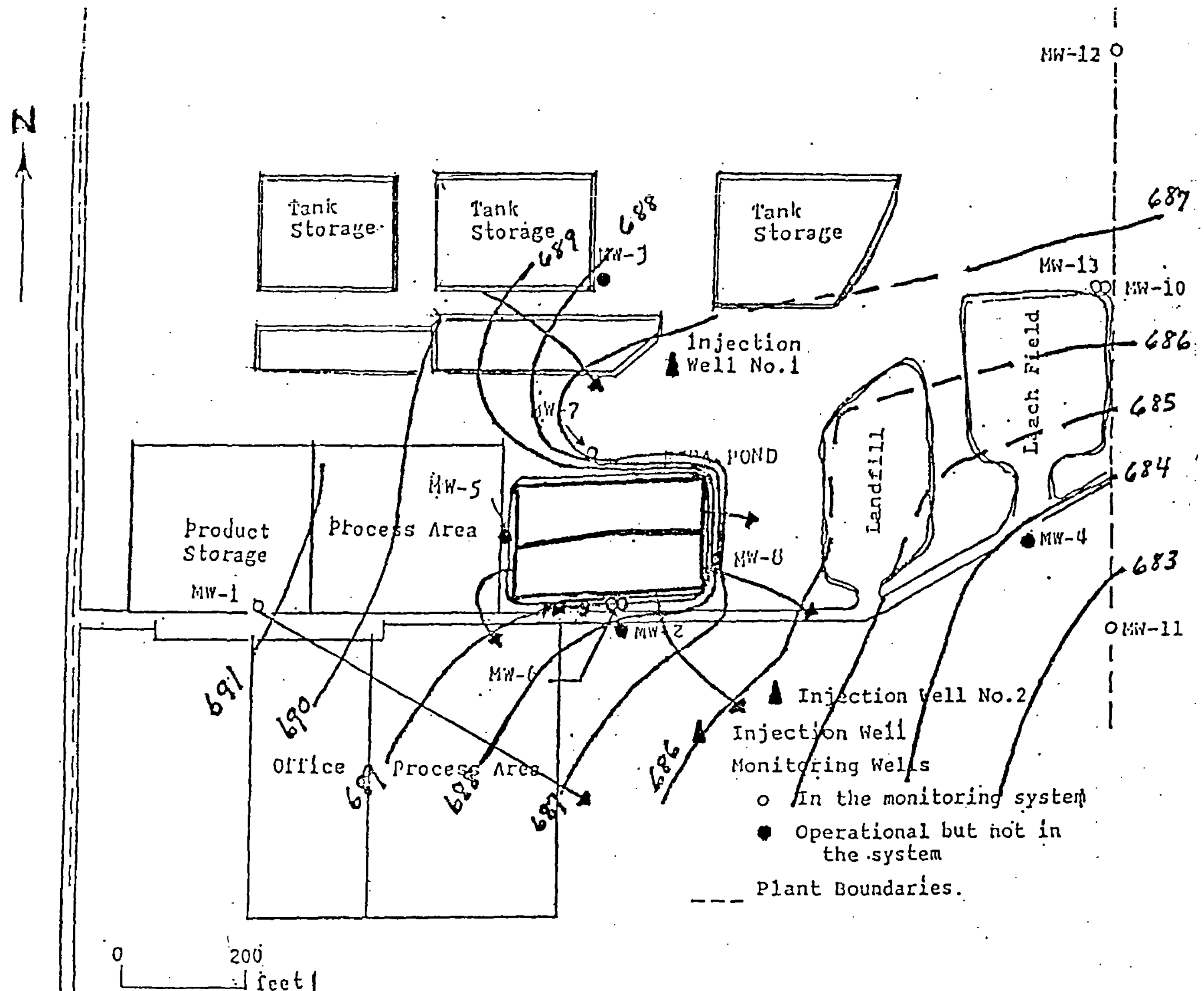

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Figure 1. Potentiometric map based on July, 1984 water level elevation. Contour interval is one ft and elevations are above msl.

northern half of the eastern boundary of the plant has not been contaminated.

The extent of the migration has been determined from the Darcy's formula. When the groundwater samples were collected for this quarter, the elevation of groundwater was measured in all the monitoring wells (Table 2). Based on the elevations taken from the shallow wells, a potentiometric map has been prepared (Figure 1) and the direction of regional groundwater flow has been estimated from elevations in MW-1 (G101), MW-4 (G104) and MW-12 (G112). The regional flow direction is towards east-southeast and the hydraulic gradient is 0.007 (4 ft/550 ft) in the unaffected areas. This flow direction and the hydraulic gradient are in agreement with those in the July 1984 Semi-annual assessment report.

Migration of waste fluid has changed groundwater elevations, general flow direction and the hydraulic gradient near the impoundment. A groundwater mound formed beneath the impoundment. From Figure 1, it is estimated that the distortion of groundwater contours occurred to a distance of 250 ft in the regional flow direction from the impoundment. The hydraulic gradient averages 0.024 in this affected area.

Groundwater Velocity and Extent of Contamination in Horizontal Direction

The horizontal component of the velocity of the groundwater flow

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Table 2. Depth to and elevation of water levels in all monitoring wells at the Cabot Plant

WELL NUMBER	Ground Elevation, Ft	MEASUREMENT			Level difference in paired wells, Ft
		Depth to Water, Ft	Elevation of* water level, Ft	Measurement Date	
(MW-1) G101	693.44	2.17	691.27	7/9/84	
MW-2	690.68	3.00	687.68	7/6/84	
MW-3	690.87	3.17	687.70	7/6/84	
MW-4	686.90	3.17	683.73	7/6/84	
MW-5	694.04	4.15	689.89	7/6/84	
(MW-6) G106	691.84	2.83	689.01	7/9/84	19.09
(MW-9) G109	691.59	21.67	669.92	7/6/84	
(MW-7) G107	690.60	4.33	686.27	7/9/84	
(MW-8) G108	691.14	4.17	686.97	7/9/84	
(MW-10) G110	689.66	2.83	686.83	7/9/84	3.53
(MW-13) G113	689.05	5.75	683.30	7/6/84	
(MW-11) G111	686.64	3.66	682.98	7/9/84	
(MW-12) G112	690.97	3.66	687.31	7/9/84	

* Water elevation is above MSL

through the glacial till (silty clay) can be estimated using a modified version of the Darcy's equation as below:

$$V_H = K \frac{dh}{dl} \frac{1}{n} \quad \text{, where}$$

V_H = Velocity , ft/yr

$*K_F$ = Field hydraulic conductivity

= 6×10^{-5} cm/sec (62.1 ft/yr), (reported previously)

$\frac{dh}{dl}$ = Hydraulic gradient,

n = Effective porosity (assumed 0.05)

The hydraulic gradient in an area unaffected by the impoundment was estimated as 0.007 from Figure 1. Thus, the groundwater velocity is calculated from the above equation as 8.69 ft/yr in this area using K_F.

From a perspective of migration of contaminant, the most important part of the impoundment to consider is the part of the plant property immediately downgradient from the eastern berm of the impoundment. The hydraulic gradient averages 0.024 in the distorted (affected) area. Using the same equation above, the average velocity is calculated as 29.8 ft/yr. That means it would take 8.4 years for a drop of fluid to travel from the impoundment to a point 250 ft away in the regional flow direction. Since the

* The calculations below were made using only field hydraulic conductivity. If the laboratory hydraulic conductivity was used, results would have been about four order of magnitude smaller.

impoundment has been there for seventeen years, since 1966, and a fluid drop from the impoundment would travel a 250 ft distance in 8.4 years; thus, there is a time period of 8.6 years to travel beyond the 250 ft distance from the northeast corner of the impoundment in the unaffected area. Because the velocity of groundwater is calculated as 8.69 ft/yr in the unaffected area, a drop of fluid from the impoundment would travel 74.7 ft in 8.6 years beyond the affected area.

Thus, it seems that the fluid that migrated from the impoundment in 1966 would travel approximately a distance of 325 ft in the regional flow direction. The potentiometric surface map in Figure 1 suggests that the travel distance would be shorter than the calculated 325 ft in other directions.

In calculation of 325 ft, it is assumed that there is no other potential contamination sources. However, a small landfill and leachfield exist on east of the impoundment approximately 200 ft and 550 ft away, respectively. Any fluid contribution from these sources would affect the flow direction and the calculated distance.

Groundwater Velocity and Contamination in Vertical Direction

The water elevation data in Table 2 for two pairs of monitoring wells (MW-6/MW-9 and MW-10/MW-13) indicate that the groundwater beneath the plant property migrates downward. Furthermore, the chemical analysis data in Table 1 suggest a slight contamination of relatively deeper groundwater by tetracholoroethylene and by methylene chloride in MW-9 (G109) which is 52.5 ft deep. However, the deeper groundwater in MW-13 (G113), located at the eastern boundary of the plant property, has not been contaminated.

The vertical component of the groundwater velocity was estimated by using a modified Darcy's equation and data from these wells. It is assumed that K is constant in horizontal and vertical directions. The modified equation is:

$$V_V = K \frac{dh}{dl} \frac{1}{n} \qquad \text{where,}$$

$$\frac{dh}{dl} = 0.92 \text{ for the G106/G109 pair, and}$$

$$\frac{dh}{dl} = 0.101 \text{ for the G110/G113 pair.}$$

(Other terms expressed before)

Using K_F, V_V would be:

$$V_V = 62.1 \text{ ft/yr} \times 0.92 \times \frac{1}{0.05} = 1150 \text{ ft/yr at G106/G109, and}$$

$$V_V = 62.1 \text{ ft/yr} \times 0.101 \times \frac{1}{0.05} = 125 \text{ ft/yr at G110/G113.}$$

If K_L, laboratory measured hydraulic conductivity, (8.3×10^{-9} cm/sec or 8.6×10^{-3} ft/yr), is used, V_V would be:

$$V_V = 8.6 \times 10^{-3} \text{ ft/yr} \times 0.92 \times \frac{1}{0.05} = 0.16 \text{ ft/yr at G106/G109 and,}$$

$$V_V = 8.6 \times 10^{-3} \text{ ft/yr} \times 0.101 \times \frac{1}{0.05} = 0.02 \text{ ft/yr at G110/G113.}$$

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It is clear that the calculated vertical velocity of groundwater is higher than the calculated horizontal velocity. Furthermore, the vertical velocity is higher near the impoundment. This is probably due to higher hydraulic gradient resulting from the groundwater mound under the impoundment.

However, the calculated velocities in the vertical direction seem to be higher for K_F and lower for K_L than it would be expected. This is probably due to both differences between K_F and K_L and to the assumption made that K was equal in horizontal and vertical directions. The value of K should be lower with depth due to compaction and lack of weathering. If it is assumed that the contaminants reached to 52 ft depth in MW-9 in seventeen years, V_V is calculated to be 3 ft/yr. At this velocity, K would be about 2.6×10^{-7} cm/sec (0.27 ft/yr) which is probably the average hydraulic conductivity of the till in vertical direction and more reasonable than K_L. Thus, the 3 ft/yr vertical velocity near the impoundment seems to be reasonable, too.

Using $K = 2.6 \times 10^{-7}$ cm/sec, the velocity of groundwater in vertical direction at the location of G110/G113 is calculated as 2.3 ft/yr.

Rate of Discharge from the Impoundment

It is the same as in the July 1984 Semi-Annual Assessment Report.

Rate of Discharge at the Property Boundary

It is the same as in the July 1984 Semi-Annual Assessment Report.

RECOMMENDATIONS

1. Annual samples should be collected from the monitoring system wells in early October 1984.

2. Water levels in all monitoring wells should be measured prior to sampling.

3. If the next quarterly (annual) water sample from well G109 indicates contamination or if the regional groundwater flow direction is determined to be towards southeast, the existing monitoring system should be modified to determine both the limit of vertical migration near the pond and the quality of shallow groundwater along the southern half of the eastern property line.

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